TITLE: The nutritional value of selected moist-soil plants and agricultural crops for Canada geese

OBJECTIVES:

1. To determine by means of proximate analysis, amino acid assay and gross energy assay, the nutrient content of ten rowcrops and moist-soil plants regularly consumed by wintering Canada geese (Branta canadensis) in Missouri

2. To determine the true metabolizable energy (T.M.E.) of ten rowcrops and moist-soil plants for Canada geese by June, 1988

3. To determine to what extent the gross energy of ten Canada goose foods varies when exposed to non-flooded and flooded conditions for 30, 60, 90, and 150 days between September, 1987 and March, 1988

DURATION: August 1, 1986 to June 30, 1989

INVESTIGATOR: Chad E. Buckley

NEED:

Migrant and wintering waterfowl commonly utilize both agricultural crops and native plants as food. Producing these foods and making them available for consumption by waterfowl is expensive because foods must be shallowly flooded for optimum use (Fredrickson and Taylor 1982). On-demand flooding requires construction of levees, as well as development of water control and water supply facilities. The initial cost of development is very expensive. On the Ted Shanks Wildlife Management Area, over 3 million dollars was spent on levees and pump stations in order to achieve water control on 2650 ha. Additional monies are required annually to maintain levees, pumps, and control structures. Controlling succession of natural vegetation and planting rowcrops are other major annual management costs (Fredrickson and Taylor 1982).

Because so much money is invested in producing and making available foods for waterfowl, it is essential that managers know which foods are best suited for meeting the seasonal nutritional requirements of waterfowl. Energy is the primary requirement of wintering waterfowl (Prince 1979), although other nutrients, such as protein, may be important at times during the winter (Heitmeyer 1985). Recent studies indicate that great variation occurs in the metabolizable energy of moist-soil and rowcrop seeds for waterfowl (Sugden 1971, Hoffman and Bookhout 1985) and in the rates of deterioration of these seeds when flooded (Neely 1956, McGinn and Glasgow 1963, Shearer et al. 1969). These findings have important implications for determining: (1) the desirability of rowcrops for waterfowl, and (2) the impacts of the timing and duration of flooding.

The fraction of the total energy in a food actually available for use should be a primary consideration of waterfowl managers. Metabolizable energy values from native foods that are regularly consumed by bobwhites (*Colinus virginianus*) provide insights into the importance of understanding the availability of energy in foods (Robel et al. 1979). For example, although lespedeza is recommended as a management practice for bobwhite quail in Kansas, the M.E. of prostrate lespedeza (*Lespedeza daurica*) (3.415 Kcal/g) is well below that of giant ragweed (*Ambrosia trifida*) (4.317 Kcal/g). Ragweed grows in abundance where soils are recently disturbed; hence, producing ragweed is not difficult and costs are minimal.

Some waterfowl foods may likewise have high metabolizable energy values, yet be relatively easy and inexpensive to produce. The most recent work with M.E. in waterfowl used mallards (*Anas platyrhynchos*) and pintails (*Anas acuta*) (Hoffman and Bookhout 1985). Feeding trials using the technique of Sibbald (1977) tested seeds from 5 species of common marsh plants (*Polygonum pensylvanicum*, *Leersia oryzoides*, *Scirpus validus*, *Echinochloa walteri*, and *Sagittaria latifolia*). The results showed similar trends for mallards and pintails. Mallards metabolized the most energy from rice cutgrass (*Leersia oryzoides*) (3.00 Kcal/g dry matter) and the least from softstem bulrush (*Scirpus validus*) (0.99 Kcal/g). Another study found that the M.E. values of barley and wheat for mallards were comparable to those reported for chickens (Sugden 1971). Values for rye, however, were higher for mallards, so not all results for chickens can be directly extrapolated to waterfowl. Few metabolizable energy determinations have been made for other waterfowl species. No M.E. values are available for Canada geese. Information on metabolizable energy is also lacking for many waterfowl foods. Because wetland habitats are in short supply and efficient management is essential, managers should consider metabolizable energy when making decisions, although production of foods that supply a mix of other nutrients in addition to energy must not be overlooked. Proximate analysis and amino acid assays will provide this necessary information concerning other nutrients.

Waterfowl foods deteriorate at different rates when exposed to flooding. In two studies, soybeans (68 and 86 percent deterioration) were found to deteriorate by weight more than corn (32 and 50 percent) and smartweed seeds (Polygonum sp.) (6 and 21 percent) when flooded for 90 days (Shearer et al. 1969, Neely 1956). Proximate analysis showed that nutrient levels in seeds did not change significantly when flooded for varying lengths of time (McGinn and Glasgow 1963). However, none of these studies determined the effects of flooding on the energy content of waterfowl foods. This needs to be addressed since energy is the major requirement of wintering waterfowl (Prince 1979) and foods must be exposed to some degree of flooding for optimum use by waterfowl. Understanding how management practices and the timing of flooding influence nutritional values should further enhance the potential for effective management of wetland habitats.

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EXPECTED BENEFITS:

Previous studies have described farming practices and moist-soil management techniques as means of providing food for waterfowl (Arthur 1968, Fredrickson and Taylor 1982). Selected species of moist-soil plants can be managed for by varying the use and timing of water level manipulations and soil disturbance. Habitat quality for migrant and wintering waterfowl is generally measured in terms of the area or yield of food plants produced. Such estimates provide a relative measure of the productivity of a site, but the number of waterfowl a management area can support is also a function of the quality of foods produced. Metabolizable energy determinations will indicate which foods are most effective at supplying energy to migrant and wintering Canada geese. Those foods which are good suppliers of other nutrients, such as certain essential amino acids, will be identified by means of amino acid assay and proximate analysis. Determining the nutrient and energy content of specific foods should enable managers to better define wetland management objectives to produce high quality Canada goose foods. Additionally, this study should indicate which common Canada goose foods are least and most resistant to energy loss when flooded and suggest the optimum timing and duration of flooding to make these foods available for Canada geese.

APPROACH:

Selection of foods to be analyzed was prioritized on the basis of importance to Canada geese as judged from food habits studies. The following ten important fall and winter foods of Canada geese in Missouri (Korschgen 1955, Eggeman unpublished) will be collected for analysis as availability permits:

Moist-soil	
Echinochloa crusgalli	Barnyardgrass
Polygonum pensylvanicum	Large-seeded smartweed
Polygonum lapathifolium	Nodding smartweed
Cyperus esculentus tubers	Chufa
Sagittaria sp. tubers	Arrowhead
Setaria Faberii	Foxtail millet
Bidens sp.	Beggarticks
Rowcrop	
Sorghum vulgare	Milo
Zea mays	Corn
Glycine max	Soybeans

Mature moist-soil seeds and tubers, and rowcrop seeds will be collected by hand or with catchpans at Fountain Grove Wildlife Area in north-central Missouri. For each foodstuff, five plots (4 sq. meters) will be randomly selected in each of six randomly selected agricultural fields or moist-soil units. If a plot does not contain the desired foodstuff, another will be randomly selected from the same field. All mature seeds or tubers from each plant in the plot will be collected. For comparison with other areas, barnyardgrass, large-seeded smartweed, corn, and milo seeds will be collected according to the same sampling plan at Swan Lake National Wildlife Refuge, Ted Shanks Wildlife Area, and Duck Creek Wildlife Area. These samples will be analyzed for gross energy and proximate analysis only.

Different amounts of foodstuff will be required for each objective. Approximately 50 g of each food item will be needed for proximate analysis, amino acid assay, and gross energy determination. 500 g of each food will be required for feeding trials to determine metabolizable energy. 1.0 liter of each food will be collected for determination of the effects of flooding on energy content. Each sample of seeds and tubers will be separated from chaff, washed, oven-dried, and dry weight determined.

To accomplish objective 1, foods will be ground in a Wiley mill finely enough to pass through a 1-mm mesh screen. A sample from each plot will be assayed for gross energy. Gross energy determinations will be made with a Parr adiabatic oxygen bomb calorimeter at the University of Missouri Animal Science Research Laboratory. Samples from all plots in each field or moist-soil unit will be pooled and mixed for proximate analysis. For amino acid assay, all samples collected at Fountain Grove will be pooled and mixed, and one amino acid profile determined. Proximate analysis and amino acid assay will be conducted by the University of Missouri Agricultural Experiment Station Chemical Laboratories.

Twenty adult female Canada geese (Branta canadensis interior) will be captured at Swan Lake National Wildlife Refuge for use in metabolizable energy determinations. They will be held 3 or 4 to a pen (approximately 5 by 6 feet) at the Porter Street Poultry Research Facility, Columbia, MO, for several weeks before feeding trials begin. Geese will be fed a balanced maintenance diet supplemented with corn prior to and between feeding trials and will have access to fresh water at all times. Geese will not have access to grit (Sibbald 1983). Photoperiod and temperature will be controlled according to National Research Council guidelines (1985).

Procedure for true metabolizable energy determination will follow that of Sibbald (1976, 1983) and Hoffman and Bookhout(1985). Twelve experimental and three control birds will be used in each feeding trial. The birds will be fasted for 24 hours prior to each trial. Each goose will be held in an individual metabolism cage (61 x 76 x 61 cm) (Williams and Kendeigh 1982) with a plastic tray to collect excreta. Each experimental bird will be precision-fed 35 g of foodstuff through a 1.2 by 40 cm stainless steel tube with attached funnel for each trial. Thirty-five grams is approximately 1% of the body weight (recommended by Sibbald 1976) of an adult female interior Canada goose (7.7 lbs according to Bellrose 1980). A total of 420 g of foodstuff will be required for all geese for each feeding trial. Control birds will not be fed during the feeding trial. Excreta will be collected quantitatively after 48 hours, rinsed into 500 ml plastic bottles, and frozen. They will later be oven-dried, dry weight determined, allowed to come to equilibrium with atmospheric moisture, and weighed. Each sample will then be ground in a Wiley mill finely enough to pass through a 1-mm mesh screen and assayed for gross energy in a Parr adiabatic oxygen bomb calorimeter. Sufficient time will be allowed for all geese to return to normal body weight prior to the next feeding trial.

True metabolizable energy will be calculated according to Sibbald (1976):

$$T.M.E.\ (kcal/g) = (G.E._f \times X) - (Y_{ef} - Y_{ec})/X$$

where $G.E._f$ is the gross energy of the foodstuff (kcal/g),
Y_{ef} is the energy voided as excreta by the experimental bird,
Y_{ec} is the energy voided as excreta by the control bird, and
X is the weight of the foodstuff fed (g).

To determine the effects of flooding on energy content, selected food items will be exposed to non-flooded and flooded conditions for 30, 60, 90, and 150 days. Three replications will be made in non-flooded and flooded fields for each food and each duration. For each trial, 30 cc of seed will be weighed and placed in a nylon mesh bag along with a numbered aluminum tag for identification. Each bag will be wired to a post and placed on the substrate of the appropriate field on about October 1, 1987. Bags will be covered with a wire mesh cage for protection. After 30, 60, 90, and 150 days, a bag containing each food will be collected from each of the six sites. The food will then be washed, dried, dry weight determined, and assayed for gross energy content. Dry weight deterioration will be calculated and change in gross energy will be determined by comparison of the final energy content per gram dry weight with original gross energy per gram dry weight for each food.

Statistical tests applied to the data will include analysis of variance, Duncan's multiple range test, t-test, and Chi-square test as applicable.

LOCATION:

Waterfowl food items will be collected at Fountain Grove Wildlife Area in north-central Missouri. Additional collections will be made at Swan Lake National Wildlife Refuge, Ted Shanks Wildlife Area, and Duck Creek Wildlife Area. Feeding trials will be conducted in Columbia, MO at the University of Missouri Porter Street Poultry Research Facility.

RELATED FEDERAL PROJECTS: None

LITERATURE CITED:

Arthur, G.C. 1968. Farming for Canada geese. Pages 112-115 in Hine, R.L., and C. Schoenfield, ed. Canada goose management. Dembar Educ. Research Services, Inc.: Madison, Wis.

Bellrose, F.C., Jr. 1980. Ducks, geese and swans of North America, 3rd ed. Stackpole Books: Harrisburg, Penn.

Fredrickson, L.H., and T.S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. U.S. Fish and Wildlife Service Resource Publication 148. 29pp.

Heitmeyer, M.E. 1985. Wintering strategies of female mallards related to dynamics of lowland hardwood wetlands in the upper Mississippi delta. Ph.D. Dissertation, Univ. of Missouri - Columbia.

Hoffman, R.D., and T.A. Bookhout. 1985. Metabolizable energy of seeds consumed by ducks in Lake Erie marshes. Trans. N. Am. Wildl. and Natur. Resour. Conf. 50:557-565.

Korschgen, L.J.1955. Fall foods of waterfowl in Missouri. Mo. Dept. Cons. P-R Ser. 14. 41pp.

McGinn, L.R., and L.L. Glasgow. 1963. Loss of waterfowl foods in ricefields in southwest Louisiana. Proc. Southeastern Game and Fish Comm. 17:69-79.

National Research Council. 1985. Guide for the care and use of laboratory animals. NIH Publication No. 85-23. 83pp.

Neely, W.W. 1956. How long do duck foods last underwater? Trans. N. Am. Wildl. Conf. 21:191-198.

Prince, H.H. 1979. Bioenergetics of postbreeding dabbling ducks. Pages 103-117 in Bookhout, T.A., ed. Waterfowl and wetlands - an integrated review. Lacrosse Printing Co., Inc.: LaCrosse, Wis.

Robel, R.J., A.R. Bisset, T.M. Clement, Jr., R.D. Dayton, and K.L. Morgan. 1979. Metabolizable energy of important foods of bobwhites in Kansas. J. Wildl. Manage. 43:982-987.

Shearer, L.A., B.J. Jahn, and L. Lenz. 1969. Deterioration of duck foods when flooded. J. Wildl. Manage. 33:1012-1015.

Sibbald, I.R. 1976. A bioassay for true metabolizable energy in feedingstuffs. Poultry Sci. 55:303-308.

Sibbald, I.R. 1977. The true metabolizable energy system. Part I. Advantages of T.M.E. in poultry feed formulation. Feedstuffs 49:21-22.

Sibbald, I.R. 1983. The T.M.E. system of feed evaluation. Animal Research Contribution 83-1. Research Branch, Agriculture Canada. 89 pp.

Sugden, L.G. 1971. Metabolizable energy of small grains for mallards. J. Wildl. Manage. 35:781-785.

Williams, J.E., and S.C. Kendeigh. 1982. Energetics of the Canada goose. J. Wildl. Manage. 46:588-600.

SCHEDULE:

This study will be conducted from August 1,1986 to June 30, 1989 with the following schedule:

Activity	J	A	S	O	N	D	J	F	M	A	M	J
1986-87												
Site selection and technique assessment		x	x									
Literature review		x	x	x								
Detailed project proposal				x	x							
Seed collections					x	x	x					
Feeding trials							x	x	x			
Sample preparation and analysis							x	x		x	x	x
Data compilation and analyses (1987)	x	x										
Progress report (1987)			x									
1987-88												
Seed collections			x	x	x	x						
Feeding trials							x	x	x			
Sample preparation and analysis					x	x			x	x	x	x
Data compilation and analyses (1988)	x	x	x									
Project report (1988)			x									
1988-89												
Thesis writing		x	x	x	x	x						
Manuscript preparation				x	x	x						
Final report						x						

REPORTING:

Quarterly reports will be submitted to the Missouri Department of Conservation and an annual report will be prepared each August. An M.S. thesis will be prepared on completion of the study. Publications will be submitted to appropriate journals.

PROJECT LEADERS:

David A. Graber, Wildlife Research Biologist, Mo. Dept. Cons., 1110 College Ave., Columbia, MO 65201.

Leigh H. Fredrickson, Professor, Gaylord Laboratory, University of Missouri - Columbia, Puxico, MO 63960.

Cooperators
Dr. Jim E. Savage, Animal Science Research Center, University of Missouri, Columbia, MO 65211

BUDGET:

FY87

Nutritional Analyses	
Proximate Analysis (132 samples at $1016/50 samples)	$ 2682.24
Amino Acid Profile 10 samples at $90 for 1st $75 for 2nd-5th $60 for 6th +	690.00
Gross Energy Assay (660 samples at $0.00 ea.)	0.00
Calorimeter Capsules	30.00
Fuse Wire	20.00
M.E. Determinations	
Cages	200.00
Maintenance Diet	200.00
500-ml Plastic Bottles	50.00
Gross Energy Assay (150 samples at $0.00 ea.)	0.00
Student Stipend	7333.37
TOTAL	$ 11,205.61

FY88

Nutritional Analyses	
Proximate Analysis (132 samples at $1016/50 samples)	$ 2682.24
Amino Acid Profile 10 samples	690.00
Gross Energy Assay (660 samples at $0.00 ea.)	0.00
M.E. Determinations	
Maintenance Diet	200.00
500-ml Plastic Bottles	50.00
Gross Energy Assay (150 samples at $0.00 ea.)	0.00
Flooding Effects	
Nylon Mesh Bags (240)	150.00
Aluminum Tags (240)	50.00
Wire Mesh	50.00
Gross Energy Assay (240 samples at $0.00 ea.)	0.00
Student Stipend	8500.00
TOTAL	$ 12,372.24

FY89

Student Stipend	$ 4500.00